Primary Intraocular Lens Implantation for Unilateral Idiopathic Cataract in Children

Meng-Ling Yang[1,2], MD; Ken-Kuo Lin[2], MD; Chiun-Ho Hou[2], MD; Yu-Sung Liang[3], MD; Jiahn-Shing Lee[2], MD, PhD

Background: To examine the efficacy of intraocular lens implantation on visual rehabilitation and ocular growth in children with unilateral idiopathic cataracts.

Methods: Preoperative characteristics, visual outcome and postoperative refraction change were analyzed through a retrospective study of the charts of children who underwent cataract removal and primary intraocular lens implantation for unilateral idiopathic cataracts between 1994 and 2003.

Results: Thirty-one children were included in this study. Preoperatively, 83% of the eyes with cataracts had best corrected visual acuity (BCVA) of less than 20/200. Posterior subcapsular opacity was the most common type of cataract. The average age at surgery was 66.8 months (range 14-115 months) and the mean follow-up was 43.4 months (range 12-117 months). At the final visit, there was no significant difference in refractive development between the pseudophakic eyes and the fellow eyes of the subjects. Sixty percent of the pseudophakic eyes had a BCVA of 20/200 or better and 37% had a BCVA of 20/60 or better. Preoperative visual acuity was the only significant factor related to visual outcome.

Conclusion: Primary intraocular lens implantation in children with unilateral idiopathic cataracts is an effective treatment for visual rehabilitation. The refractive development of the pseudophakic eyes was not significantly different from the fellow eyes.

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Key words: unilateral idiopathic cataract, intraocular lens implantation, pseudophakia, refractive development

Cataract is one of the major causes of childhood blindness, with a prevalence of 1.2 to 6.0 cases per 10,000 births.(1) In unilateral cases, there is not only deprivation of formed vision by the cataract but also a suppression effect on binocular competition that can result in severe amblyopia.(2) Although techniques for removal of cataracts in young children have improved over the past three decades, visual rehabilitation for children with unilateral cataracts remains challenging.(3) Furthermore, only a few studies address those children with unknown etiology.(4) Herein, we studied 31 consecutive children who underwent cataract extraction and primary posterior chamber intraocular lens (IOL) implantation for uni-

From the [1]Department of Pediatric Ophthalmology, Chang Gung Children's Hospital, Taipei, Chang Gung University College of Medicine, Taoyuan, Taiwan; [2]Department of Ophthalmology, Chang Gung Memorial Hospital, Taipei, Chang Gung University College of Medicine, Taoyuan, Taiwan; [3]Evergreen Eye Clinic, Taipei, Taiwan.
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Correspondence to: Dr. Jiahn-Shing Lee, Department of Ophthalmology, Chang Gung Memorial Hospital. No. 5, Fusing St., Gueishan Township, Taoyuan County 333, Taiwan (R.O.C.) Tel.: 886-3-3281200 ext. 8666; Fax: 886-3-3287798;
E-mail: leejsh@cgmh.org.tw

lateral idiopathic cataracts. Efforts were focused on determining the possible contributing factors of long-term visual outcome and postoperative refractive development.

METHODS

Clinical records of patients who were under 12 years of age and who underwent cataract removal and primary IOL implantation at Chung Gung Memorial Hospital between January 1994 and 2003 were reviewed retrospectively. Eyes with cataracts associated with trauma, steroid use, infection, systemic disease, family history or other ocular anomalies (such as microphthalmus or persistent hyperplastic primary vitreous) were excluded. Patients with ocular pathology of the fellow eye or those without regular follow-up for at least 12 months were also excluded. Thirty-one patients who met the criteria were included in the study.

The preoperative examination included assessment of fixation, visual acuity, slit-lamp biomicroscopy, intraocular pressure measurement and fundus examination. In patients where the fundus was not visible because of dense cataract, B-scan ultrasonography was performed to rule out associated posterior segment diseases. According to the patients' history, the age of onset was recorded as the date of presentation of cataract-associated signs and symptoms.

Surgeries were performed by 4 of our authors. All surgeries were performed under general anesthesia with a standardized technique, which included limbal incision or scleral groove, anterior capsulorhexis and lens matter aspiration with irrigation-aspiration (I/A) syncope or phacoemulsification tip. Methyl cellulose viscoelastic material was used in all cases. Patients under 3 years of age had additional primary posterior capsulotomy and anterior vitrectomy. Then an IOL was placed in the capsular bag. The IOLs were all polymethyl methacrylate (PMMA), one-piece, UV-absorbing and biconvex. The selection of IOL power calculation formula was dependent on the preference of the surgeon, and the target refraction was emmetropia or some degree of hyperopia. A peripheral iridectomy was performed on some patients. Subconjunctival injection of gentamicin sulfate (10 mg) and dexamethasone sulfate (1 mg) was given to each patient, and then the eye was patched. After surgery, all patients received steroid-antibiotic eye ointment twice daily for 3 weeks, which was tapered off thereafter.

A complete ocular examination, including refraction, slit-lamp biomicroscopy, intraocular pressure measurement and fundus examination was performed on follow-up visits. Visual acuity was assessed with fixation behavior in infants and Landot C chart at 6-m distance for verbal children. Spectacle overcorrection was prescribed. Part-time occlusion therapy was indicated for those with amblyopia and compliance was monitored carefully.

Upon retrospective review of the patient charts, we recorded the demographics, presenting symptoms with date of onset, cataract type, final visual acuity and refractive change. The clinical data were analyzed utilizing Paired-Samples T Tests and $p < 0.05$ was considered to be a statistically significant difference.

RESULTS

The characteristics of the 31 children with unilateral idiopathic cataracts are summarized in Table 1. Fourteen patients (45.2%) were male and 17

Table 1. The Characteristics of 31 Children with Unilateral Idiopathic Cataracts

Characteristic	
Male: Female ratio	1: 1.2
OD: OS ratio	1.2: 1
Pre-op BCVA*	CF to 20/60
Age at surgery (months)	
Range	14 to 115
Mean ± SD	66.8 ± 25.0
Axial length† (mm)	
Range	20.25 to 25.99
Mean ± SD	22.62 ± 1.76
Follow-up duration (months)	
Range	12 to 117
Mean ± SD	43.4 ± 32.7
Final BCVA‡	CF to 20/20
Total refractive change (diopters)	
Range	–7.75 to 1.38
Mean ± SD	–1.67 ± 2.22

Abbreviations: OD: right eye; OS: left eye; BCVA: best corrected visual acuity; SD: standard deviation; CF: counting fingers. *: data was not available in 7 eyes; †: data was not available in 6 eyes; ‡: data was not available in one eye.

patients (54.8%) were female. Seventeen patients (54.8%) had the cataract in the right eye and fourteen patients (45.2%) in the left eye. According to the families' statements, the mean possible onset of the cataracts (presentation of cataract-associated signs and symptoms) was at 51.6 months of age (median 55.0 months, range 0-115 months). Eleven patients (35.5%) were identified through vision screening tests. Eleven patients (35.5%) presented with strabismus. Seven patients (22.6%) complained of blurred vision and 2 patients (6.5%) presented with leucocoria.

Posterior subcapsular opacity (15 eyes, 48.4%) was the most common morphological type of cataract in the study, followed by nucleus opacity (7 eyes, 22.6%) and lamellar opacity (3 eyes, 9.7%). Total lens opacity was noted in 2 eyes (6.5%). The cataract morphology could not be determined due to incomplete charts in the remaining 4 eyes (12.9%).

Axial length measurements were performed on both the cataract eye and the fellow eye in 22 patients preoperatively. The mean axial length was 22.52 mm in the cataract eye (median 21.93, range 20.25-25.99 mm) and 22.58 mm in the fellow eye (median 22.48, range 21.31-25.61 mm). In 6 patients, the interocular axial length difference was within 0.5 mm. The cataract eye was shorter than the fellow eye by up to 0.5 mm in 10 patients and longer by up to 0.5 mm in the other 6 patients.

The mean age at surgery of the children was 66.8 months (median 70.0 months, range 14-115 months). The mean power of the implanted IOLs was 22.2 diopters (median 22.5, range 12-30 diopters). After surgery, the patients had regular follow-ups for 12-117 months (mean 43.4 months, median 32.0 months). No patients in this study had severe complications, such as glaucoma, endophthalmitis or retinal detachment.

Preoperatively, all the cataract eyes had visual acuity worse than 20/50 and 83% of them were worse than 20/200. At the final visit, 60% of the pseudophakic eyes had visual acuity of 20/200 or better and 37% of them had visual acuity of 20/60 or better. After converting to logMAR equivalents, we used multifactor stepwise regression (SPSS, V11) to determine possible factors that contributed to the visual outcome. While gender, right or left eye, type of presentation, with or without strabismus, type of cataract, age at onset, age at surgery, interocular axial length difference, power of implanted IOL and rate of myopic shift did not affect visual outcome, preoperative visual acuity was a significant factor (Table 2). This seemed to indicate that poor preoperative visual acuity could be related to a worse visual outcome.

Comparing the refractive status at the final visit to that at 1 month after surgery, the mean refractive change was –1.67 diopters (median –1.13, range –7.75 to 1.38) in the pseudophakic eye and –0.81 diopters (median –0.25, range –7.00 to 0.88) in the fellow eye. Table 3 shows the myopic shift by age group. For those patients (n = 18) who had surgery before they were 6 years of age, the mean myopic shift was -0.036 ± 0.068 diopters/month in the pseudophakic eyes and -0.016 ± 0.060 diopters/month in the fellow eyes. For those patients (n = 13) who had surgery after they were 6 years of age, the mean myopic shift was -0.025 ± 0.053 diopters/month in the pseudophakic eyes and -0.021 ± 0.022 diopters/month in the fellow eyes. However, there was no significant difference between the pseudophakic eyes and the fellow phakic eyes in either age group ($p = 0.413$ and 0.779, respectively, using Paired-Samples T Tests). Using multifactor regression (SPSS, V11) to identify the possible factors that contributed to the rate of refractive change, neither final visual acuity, 1-month postoperative refraction, age at surgery or preoperative axial length were significant (Table 4).

Table 2. Possible Factors Contributing to Visual Outcome

	Statistical difference*
Gender	$p = 0.303$
Right or left eye	$p = 0.398$
Type of presentation	$p = 0.363$
With or without strabismus	$p = 0.986$
Type of cataract	$p = 0.601$
Age at onset	$p = 0.113$
Age at operation	$p = 0.900$
Interocular axial length difference	$p = 0.220$
Preoperative visual acuity	$p = 0.008^{\dagger}$
Power of intraocular lens	$p = 0.227$
Rate of myopic shift	$p = 0.522$

*: Statistical test: multifactor stepwise regression; †: $p < 0.05$: statistically significant.

Table 3. The Refractive Changes (Spherical Equivalent) in the Operated-on Eye and Fellow Eye by Age Group

Age at surgery (years)	No. of eyes	Mean follow-up (months)	Rate of refractive change Mean ± SD (diopters/m)			Enyedi et al. Rate of refractive change Mean ± SD (diopters/m)	
			Operated-on eye	Fellow eye	Statistical difference*	Operated-on eye	Fellow eye
0-2	1	86	–0.03	–0.07	None	–0.10 ± 0.07	–0.01 ± 0.01
2-4	7	40	–0.08 ± 0.06	0.00 ± 0.02	$p = 0.078$	–0.05 ± 0.07	0.00 ± 0.03
4-6	10	22	–0.01 ± 0.06	–0.03 ± 0.08	$p = 0.611$	–0.06 ± 0.14	–0.01 ± 0.03
6-8	9	61	–0.03 ± 0.06	–0.02 ± 0.02	$p = 0.474$	–0.04 ± 0.10	0.00 ± 0.01
> 8	4	52	–0.01 ± 0.04	–0.02 ± 0.02	$p = 0.482$	–0.03 ± 0.12	0.00 ± 0.01

Abbreviations: SD: standard deviation; *: Statistical test: Paired-Samples T Test.

Table 4. Possible Factors Contributing to the Rate of Refractive Change

	Statistical difference*
Final visual acuity	$p = 0.956$
1-Month postoperative refraction	$p = 0.521$
Age at operation	$p = 0.779$
Preoperative axial length	$p = 0.218$

*: Statistical test: multifactor regression.

DISCUSSION

Unilateral cataracts in children can be congenital or acquired. The causes include trauma, ocular abnormalities, intrauterine infection, masked bilateral cataracts and idiopathic.[5] Studies suggest that early (before 4 to 6 months of age), adequate and aggressive treatment is the only way to achieve good visual results in patients with unilateral congenital cataracts.[6-8] Good visual function is not likely if treatment is delayed after irreversible amblyopia occurs. However, when an older child presents with a unilateral cataract it can be difficult to know whether the cataract was present during the critical period and, if so, to what extent the cataract interfered with visual development. Often, the clinician is unsure of the benefits of removing the cataract in a child who presents late after the critical period of visual development.

Wright et al. reviewed the results of 18 patients with unilateral presumed congenital cataracts and 7 attained a visual acuity of 20/60 or better.[9] In Kushner's report, 14 out of 25 children with monocular cataracts had a final visual acuity equal to 20/50 or better.[10] Both Wright and Kushner did not exclude microphthalmus or persistent hyperplastic primary vitreous cases, and they used aphakic contact lenses for visual rehabilitation. In recent years, IOL implantation has gained wide acceptance for pediatric cataract patients.[11,12] Greenwald and Glaser reported 85% of patients who became monocular pseudophakia after 2 years of age showed final acuity better than 20/100.[13] In the report by Awner et al., 52% of unilateral pseudophakic children under 4 years of age achieved 20/40 or better.[14] However, traumatic cataract was not excluded in either of their studies. In our 31 cases of primary IOL implantation for unilateral idiopathic cataracts, 60% had a final visual acuity of 20/200 or better and 37% achieved 20/60 or better. Using primary IOL implantation seems to produce effective visual rehabilitation for children with unilateral cataracts of unknown origin.

Is it possible to predict the visual outcome of unilateral idiopathic cataracts preoperatively? Previous studies have reported that cataract morphology may be related to the visual prognosis. Unilateral cataracts with good prognosis include lamellar cataracts and posterior lenticonus.[15] These types of cataracts are often partial at birth and can progress over time, allowing for early visual development. Another factor is the presence of strabismus. Hosal et al. found that the presence of strabismus increases the risk of failure to achieve good visual acuity by 5.45-fold in children after monocular cataract removal.[16] In our study, the only prognosis-related factor was preoperative visual acuity. Poor preoperative visual acuity may reflect more severe cataracts and possibly more severe amblyopia.

Refractive development from infancy to adulthood averages 0.9 diopters change in normal eyes[17] and it has been reported to average 10.0 diopters in aphakic eyes.[18] Superstein et al. concluded pseudophakic eyes showed less postoperative myopic shift than aphakic eyes.[19] For pseudophakic eyes, Crouch et al. reported the greatest rate of refractive change occurred between 1 and 3 years of age, and followed a more linear trend after 3 years of age.[20] Enyedi et al. observed a greater mean myopic shift in the pseudophakic eye compared with the fellow eye, especially in the younger patient group.[21] A comparison of our results and those from a previous study are shown in Table 3. Our results also showed a myopic shift in the pseudophakic eyes. However, the myopic shift of the pseudophakic eyes was not significantly different from that of the fellow eyes. Myopic shift in pseudophakic eyes has always been explained as the result of excessive axial elongation due to visual deprivation and amblyopia.[22] Enyedi et al. believed that it was the result of normal eye growth with a fixed IOL power, while the normal phakic lens power changes to compensate for axial elongation.[21] However, these factors were not statistically significant in our study. The differences between our study and previous reports may be due to different study designs and patient inclusion. Race could be another contributing factor, as greater myopic shift in the fellow eyes of our patients compared to others' data may represent the higher prevalence and greater severity of myopia in Asian countries, especially in Taiwan.[23,24]

Most authors recommend implanting an IOL with a power that will undercorrect (targeting a hyperopic correction) a child of 6 years of age or less, in anticipation of a significant myopic shift over time, and fully correct a child 6 years of age or older.[21,22,25] Based on the results of this study, we would recommend a simple guideline for children of various ages with monocular idiopathic cataract: choose the IOL power with a target refraction that is the same as the fellow eye refraction unless the fellow eye is highly myopic or highly hyperopic. For example, the target refraction of IOL implantation would be 2-diopters-undercorrection for a 3-year-old boy if his fellow eye is 2.00 diopters hyperopic. Hopefully, the patient would not develop anisometropia and would go on to enjoy binocular vision comfortably with spectacle correction alone in adulthood.

In conclusion, primary IOL implantation in children with unilateral idiopathic cataracts is an effective treatment for visual rehabilitation. The refractive development of the pseudophakic eyes was not significantly different from the phakic eyes. Poor preoperative visual acuity may be a risk factor that prevents a good visual outcome.

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以人工水晶體植入治療兒童單側不明原因之白內障

楊孟玲[1,2] 林耕國[2] 侯鈞賀[2] 梁有松[3] 李建興[2]

背 景：白內障是造成兒童失明的重要原因之一，尤其單側不明原因之白內障往往癒後不佳，在此報告以人工水晶體植入治療之成效。

方 法：我們收集 1994 至 2003 年間，因單側不明原因白內障接受白內障摘除及人工水晶體植入手術，並追蹤一年以上之兒童病例，分析影響癒後的可能因素及術後屈光發育的變化。

結 果：共有 31 名病例列入研究，平均手術年齡爲 66.8 個月大，平均追蹤 43.4 個月。後囊混濁是最常見的白內障型態。術前有 87% 的患眼最佳矯正視力小於 20/200，術後則有 61% 的患眼最佳矯正視力達 20/200 或以上，37% 達 20/60 或以上。術前視力爲影響癒後的可能因素 ($p < 0.001$)。最後回診時患眼的屈光發育變化與對側好眼的屈光發育變化無明顯之差異。屈光發育變化不受術後勢力、術後屈光狀態、手術年齡、兩眼眼軸長度差異等因素所影響 ($p > 0.05$)。

結 論：我們報告以人工水晶體植入治療兒童單側不明原因白內障的結果：61% 的患眼術後最佳視力可達 20/200，37% 的患眼術後最佳視力可達 20/60；術前視力較差者可能合併有較深度的弱視，其手術癒後可能也較差。術後患眼的屈光發育變化與對側好眼的屈光發育變化無明顯之差異。

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關鍵詞：兒童單側白內障，人工水晶體植入，僞晶體，屈光發育

[1]長庚兒童醫院 台北院區 兒童眼科；[2]長庚紀念醫院 台北院區 眼科；長庚大學 醫學院；[3]常春眼科診所
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通訊作者：李建興醫師，長庚紀念醫院 眼科。桃園縣333龜山鄉復興街5號。Tel.: (03)3281200轉8666; Fax: (03)3287798; E-mail: leejsh@cgmh.org.tw